Ch. 2

OSCILLATORS

Dr. Mohamed Salah

4 Crystal oscillator

4 Crystal oscillator

One of the most important features of any oscillator is its *frequency stability*, or in other words its ability to provide a constant frequency output under varying load conditions

Some of the factors that affect the frequency stability of an oscillator include: temperature, variations in the load and changes in the DC power supply.

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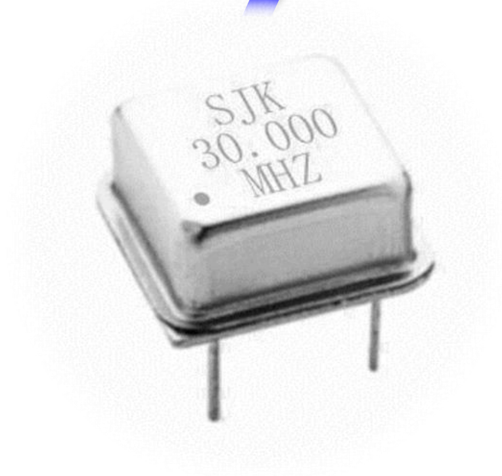
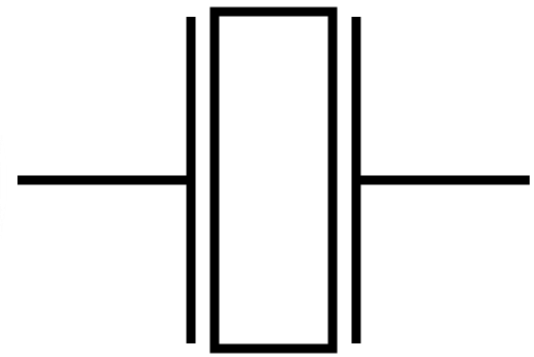
Crystal oscillator





there is a limit to the stability that can be obtained from normal **LC** and **RC** tank circuits.

To obtain a very high level of oscillator stability a **Quartz Crystal** is generally used as the frequency determining device to produce other types of oscillator circuit known generally as a **Quartz Crystal Oscillator**, (XO).

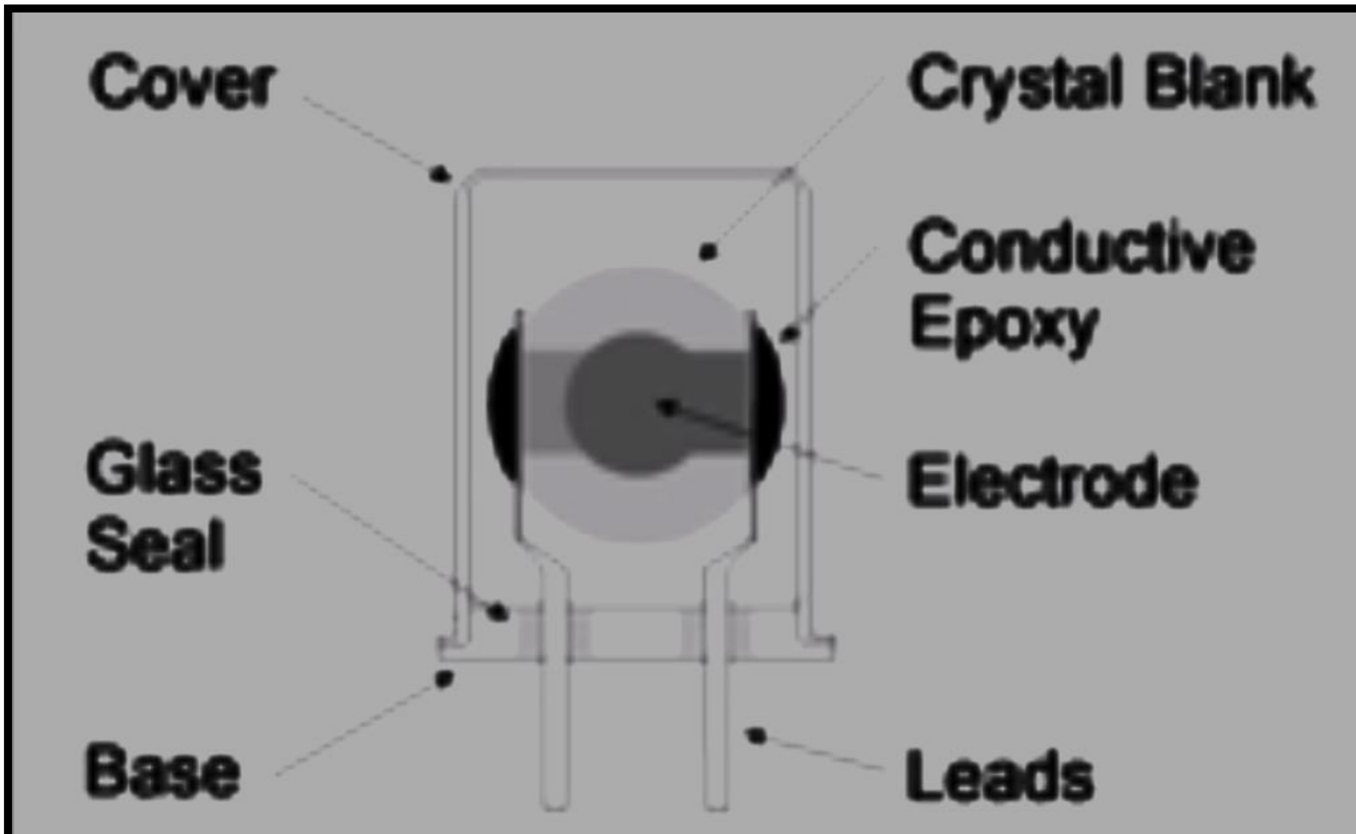
4 Crystal oscillator

When a voltage source is applied to a small thin piece of quartz crystal, it begins to change shape producing a characteristic known as the Piezo-electric effect. This piezo-electric effect is the property of a crystal by which an electrical charge produces a mechanical force by changing the shape of the crystal and vice versa, a mechanical force applied to the crystal produces an electrical charge.

This piezo-electric effect produces mechanical vibrations or oscillations which are used to replace the LC tank circuit in the previous oscillators.

4 Crystal oscillator

4 Crystal oscillator



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Crystal oscillator

The most common type of piezoelectric resonator used is the quartz crystal (because of their greater mechanical strength**), but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.**

Quartz crystals are manufactured for frequencies from a few tens of kilohertz to hundreds of megahertz.

Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cellphones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

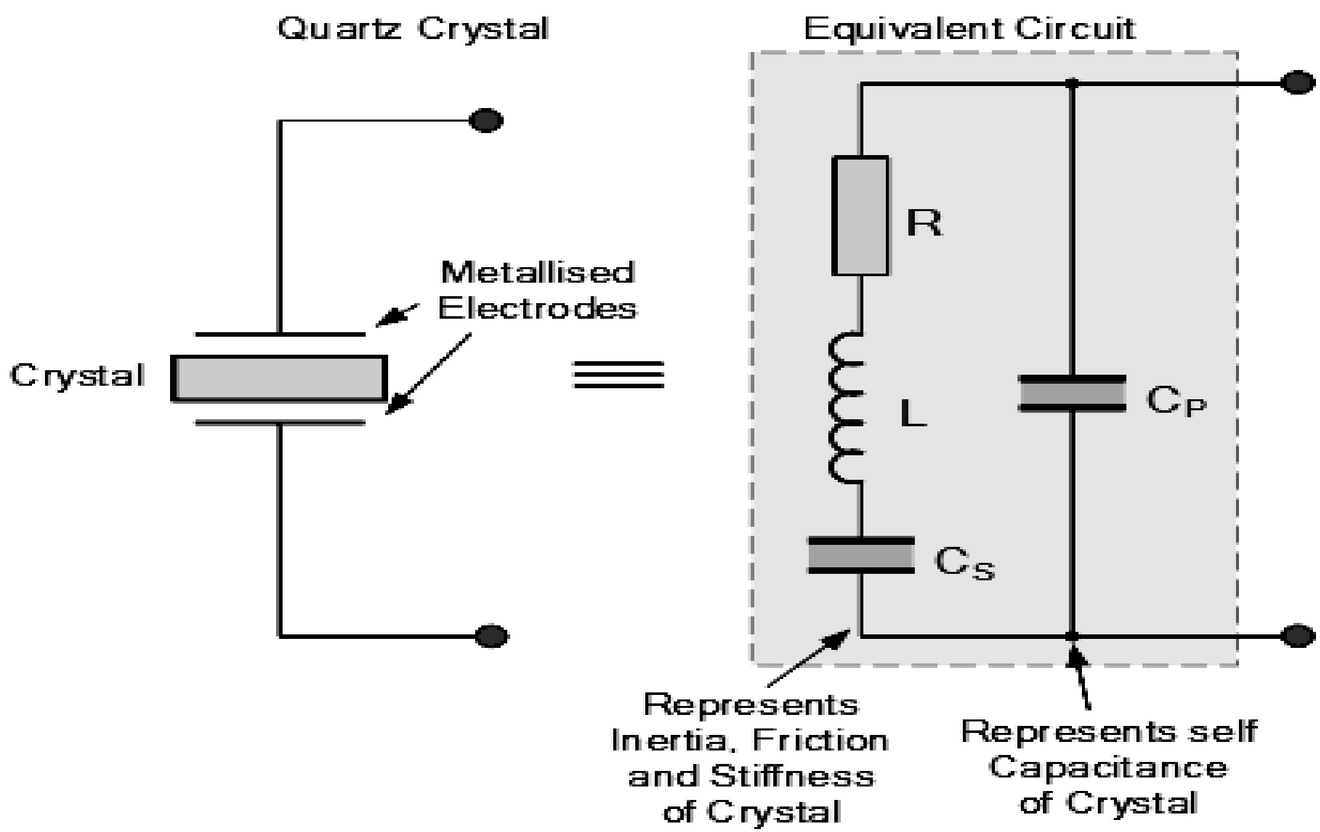
4 Crystal oscillator

The quartz crystal used in a Quartz Crystal Oscillator is a very small, thin piece or wafer of cut quartz with the two parallel surfaces metalized to make the required electrical connections. The physical size and thickness of a piece of quartz crystal is tightly controlled since it affects the final frequency of oscillations and is called the crystals "characteristic frequency". Then once cut and shaped, the crystal cannot be used at any other frequency. In other words, its size and shape determines its frequency.

4 Crystal oscillator

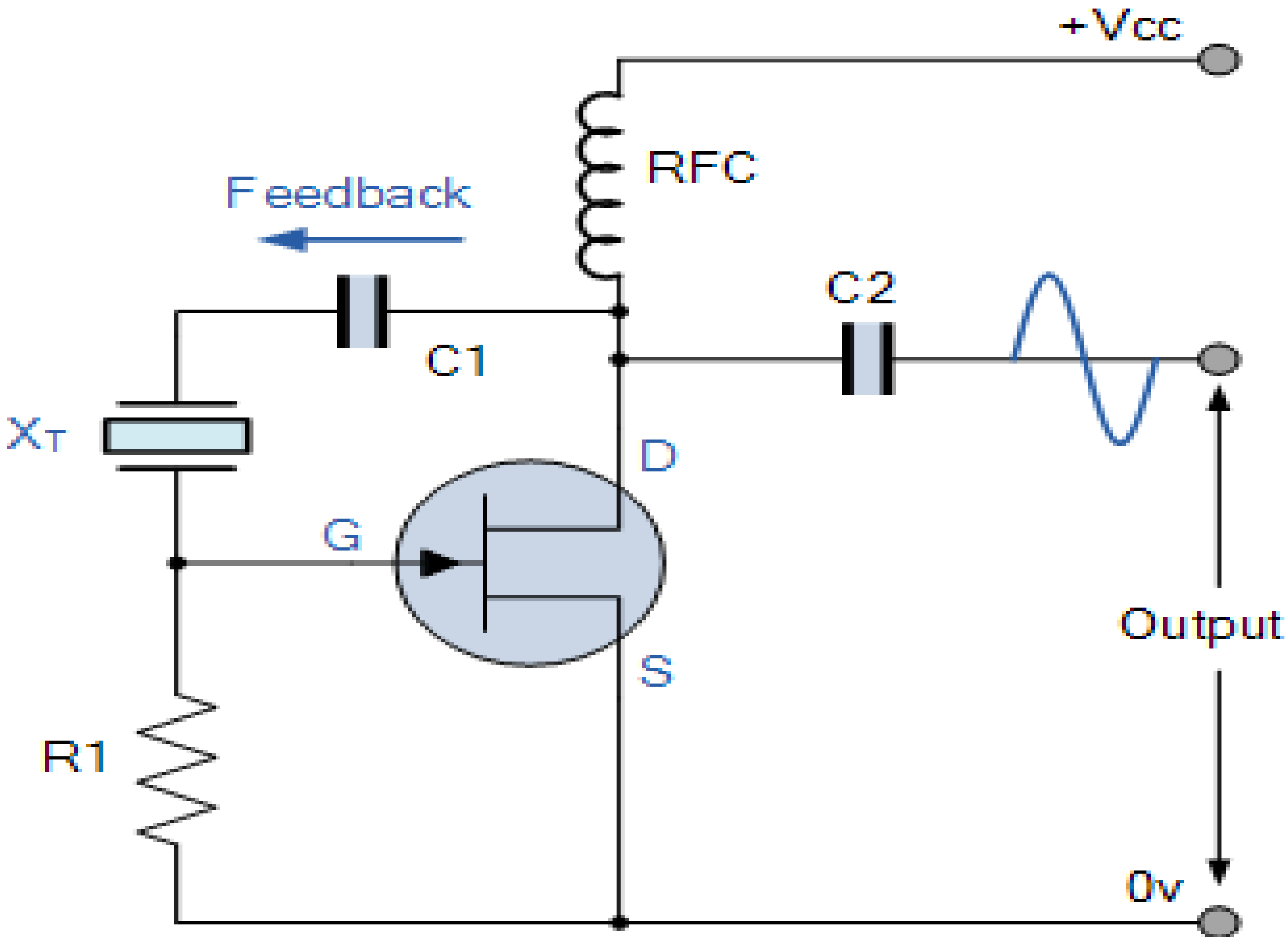
The crystals characteristic or resonant frequency is inversely proportional to its physical thickness between the two metalized surfaces.

C_p represents the electrical connections to the crystal.



4 Crystal oscillator

Pierce Crystal Oscillator



4 Crystal oscillator

Pierce Crystal Oscillator

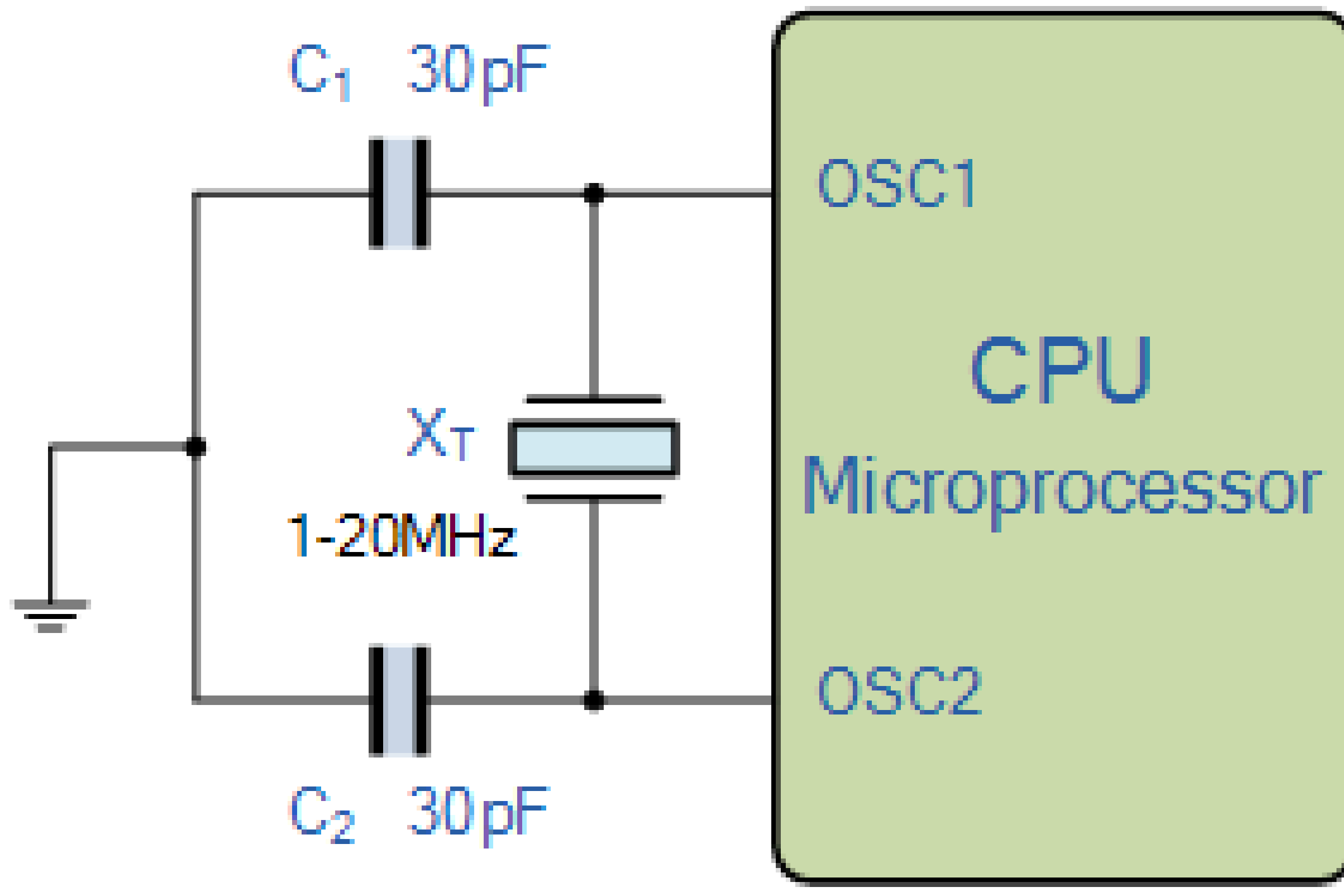
The Pierce oscillator is a crystal oscillator that uses the crystal as part of its feedback path and therefore has no resonant tank circuit. The Pierce Oscillator uses a JFET as its amplifying device as it provides a very high input impedance with the crystal connected between the output Drain terminal and the input Gate terminal as shown below.

Most digital clocks, watches and timers use a Pierce Oscillator in some form or other as it can be implemented using the minimum of components.

4 Crystal oscillator

Microprocessor Oscillator

In this application the Quartz Crystal Oscillator produces a train of continuous square wave pulses whose frequency is controlled by the crystal which in turn regulates the instructions that controls the device



Thank you

QUIZ

Multiple Choice Questions

(1) Negative feedback in an amplifier

(a) increases the voltage gain

(b) decreases the voltage gain

(c) can change it to an oscillator

(2) Transmission gain of negative feedback amplifier is

(a) Aβ

(b) 1/Aβ

(c) A/(1 + Aβ)

(d) A(1 + A)

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(3) The coils of Hartley oscillator are
(a) coupled
(b) decoupled

(4) The capacitors in Colpitt's oscillator are
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(5) The most suitable oscillator circuit for 1 MHz frequency is
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(b) Weinbridge oscillator
(c) phase-shift oscillator

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QUIZ

For the Phase shift oscillator, determine the frequency of oscillation if:

$$R_1 = R_2 = R$$

$$C_1 = C_2 = C_3 = C$$

QUIZ

$$f_{oscillation} = \frac{1}{2\pi\sqrt{3C^2RR_3 + 2C^2RR_3 + C^2R^2}}$$

$$f_{oscillation} = \frac{1}{2\pi C\sqrt{5RR_3 + R^2}} = \frac{1}{2\pi CR\sqrt{1 + 5\,\frac{R_3}{R}}}$$